

3 Organic chemistry

Calculations

Question	Answers and guidance	Marks
1	Calculation of O% = 26.6%	1
	Divide each value by atomic mass:	
	$C = \frac{59.76\%}{12} = 4.98, H = \frac{13.33\%}{1} = 13.33, O = \frac{26.6\%}{16} = 1.66$	1
	To find simplest ratio, divide each value by 1.66:	
	$C = \frac{4.98}{1.66} = 3, H = \frac{13.33}{1.66} = 8, O = \frac{1.66}{1.66} = 1$	1
	Ratio is 3 : 8 : 1	1
	So empirical formula is C ₃ H ₈ O	1
Total		5

Question	Answers and guidance	Marks
2	Calculation of H% = 11.8%	1
	Divide each value by atomic mass:	
	$C = \frac{37.8\%}{12} = 3.15, H = \frac{11.8\%}{1} = 11.8, O = \frac{50.4\%}{16} = 3.15$	1
	To find simplest ratio, divide each value by 3.15:	
	$C = \frac{3.15}{3.15} = 1, H = \frac{12.8}{3.15} = 4, O = \frac{3.15}{3.15} = 1$	1
	Ratio is 1 : 4 : 1	1
	So empirical formula is CH ₄ O	1
Total		5

Question	Answers and guidance	Marks
3	Divide each value by atomic mass:	
	$C = \frac{40.0\%}{12} = 3.33, H = \frac{6.7\%}{1} = 6.7, O = \frac{53.3\%}{16} = 3.33$	1
	To find simplest ratio, divide each value by 3.33:	
	$C = \frac{3.33}{3.33} = 1, H = \frac{6.7}{3.33} = 2, O = \frac{3.33}{3.33} = 1$	1
	Ratio is 1 : 2 : 1	1
	So empirical formula is CH ₂ O	1
Total		4

Question	Answers and guidance	Marks
4 a)	Divide each value by atomic mass:	
	$C = \frac{85.7\%}{12} = 7.14, H = \frac{14.3\%}{1} = 14.3$	1
	To find simplest ratio, divide each value by 7.14:	
	$C = \frac{7.14}{7.14} = 1, H = \frac{14.3}{7.14} = 2$	1
	Ratio is 1 : 2	1
	So empirical formula is CH ₂	1
b)	CH ₂ = 12 + 1 + 1 = 14	1
	$\frac{112}{14} = 8$	1
	so 8 × CH ₂ = C ₈ H ₁₆	1
Total		7

Question	Answers and guidance	Marks
5	Calculation of H% = $100 - (56.8 + 38.4) = 4.8\%$	1
	Divide each value by atomic mass:	
	$C = \frac{38.4\%}{12} = 3.2$, $H = \frac{4.8\%}{1} = 4.8$, $Cl = \frac{56.8\%}{35.5} = 1.6$	1
	To find simplest ratio, divide each value by 1.6:	
	$C = \frac{3.2}{1.6} = 2$, $H = \frac{4.8}{1.6} = 3$, $Cl = \frac{1.6}{1.6} = 1$	1
	Ratio is 2 : 3 : 1	1
	So empirical formula is C_2H_3Cl	1
Total		5

Structure, properties and reactions of alkanes and alkenes

Question	Answers and guidance	Marks														
1 a)																
	<table border="1"> <thead> <tr> <th></th><th>methane</th><th>ethane</th></tr> </thead> <tbody> <tr> <td>molecular formula</td><td>CH_4</td><td>C_2H_6</td></tr> <tr> <td>displayed formula</td><td> <pre> H H — C — H H </pre> </td><td> <pre> H H H — C — C — H H H </pre> </td></tr> <tr> <td>dot and cross diagram of bonding</td><td> <pre> H • x x • C • x • x H </pre> </td><td> <pre> H H x • • x x • C x • C x • x x • H H </pre> </td></tr> <tr> <td>state at room temperature</td><td>gas</td><td>gas</td></tr> </tbody> </table>		methane	ethane	molecular formula	CH_4	C_2H_6	displayed formula	<pre> H H — C — H H </pre>	<pre> H H H — C — C — H H H </pre>	dot and cross diagram of bonding	<pre> H • x x • C • x • x H </pre>	<pre> H H x • • x x • C x • C x • x x • H H </pre>	state at room temperature	gas	gas
	methane	ethane														
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state at room temperature	gas	gas														
b)	A compound that contains only carbon and hydrogen	1														
c)	They have a general formulae that can be applied to all the series, e.g. C_nH_{2n+2} OR A group of compounds where each successive member differs from the next and previous by the same type and number of atoms, e.g. CH_2	1														
d)	Carbon dioxide is produced with lots of air/oxygen	1														
	Carbon monoxide is produced with insufficient air/oxygen	1														
	Carbon (soot) is produced with very little air/oxygen	1														
Total		9														

Question	Answers and guidance	Marks
2 a) i)	$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$	1
ii)	$\begin{array}{c} \text{H} & & \text{H} \\ & \times & \times \\ & \times & \times \\ & \times & \times \\ \text{H} & & \text{H} \end{array}$	1
b)	$\begin{array}{c} \text{H} & & \text{H} & \text{H} \\ & \diagdown & / & \\ & \text{C} = \text{C} - \text{C} - \text{H} \\ & / & & \\ \text{H} & & \text{H} \end{array}$ Propene	1 1
c)	$\begin{array}{c} \text{H} & & \text{H} & \text{H} \\ & \diagdown & / & \\ & \text{C} = \text{C} - \text{C} - \text{C} - \text{H} \\ & / & & \\ \text{H} & \text{H} & \text{H} \end{array} \text{ or } \begin{array}{c} \text{H} & & \text{H} & \text{H} \\ & & & \\ \text{H} - \text{C} - \text{C} = \text{C} - \text{C} - \text{H} \\ & & \\ \text{H} & \text{H} & \text{H} \end{array}$ Butene C ₄ H ₈	1 1
d)	C ₇ H ₁₄	1
e)	Alkenes decolorise it quickly/the orange colour would disappear rapidly Alkanes would give no change in colour after adding the bromine water	1 1
Total		10

Question	Answers and guidance	Marks
3 a)	Alkanes	1
b) i)	Carbon/soot	1
ii)	Methane had insufficient/very little air/oxygen to form carbon dioxide	1 1
iii)	Open the air hole on the Bunsen.	1
c) i)	2CH ₄ + Br ₂ → 2CH ₃ Br + 2HBr 1 mark for correct formulae; 1 mark for correct balancing	2
ii)	Presence of UV light	1
iii)	Bromomethane OR hydrogen bromide	1
Total		9

Question	Answers and guidance	Marks
4 a)	$ \begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & \\ & & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{H} & \\ & & & & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} & & \end{array} $ and $ \begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & & & \\ & & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{H} & & \\ & & & & & & \\ & \text{H} & & \text{H} & & & \\ & & & & & & \\ & & & \text{H} - \text{C} - \text{H} & & & \\ & & & & & & \\ & & & \text{H} & & & \end{array} $	1 1
b)	The same molecular formulae, but different displayed formulae/structures	2
c) i)	A group of compounds where each successive member differs from the next and previous by the same type and number of atoms, e.g. CH_2 OR They have a general formulae that can be applied to all the series, e.g. $\text{C}_n\text{H}_{2n+2}$	1
ii)	Butene has the formula C_4H_8 but butane is C_4H_{10} Butene has a double bond but butane has only single bonds/butene is unsaturated and butane is saturated	1 1
d)	Bubble each gas through bromine water The butene will decolorise the bromine water	1 1
Total		9

Question	Answers and guidance	Marks
5 a) i)	$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & & \\ & \times & & \bullet & \times & & \\ \text{H} & \times & \text{C} & \times & \text{C} & \times & \text{H} \\ & \bullet & & \times & \bullet & & \\ & \text{H} & & \text{H} & & & \end{array} $ ethane $ \begin{array}{ccccccc} & \text{H} & & \times & & \times & \text{H} \\ & \times & & \bullet & & \bullet & \\ & \times & \text{C} & \times & \text{C} & \times & \\ & \text{H} & & \times & & \times & \text{H} \end{array} $ ethene	1 1
ii)	Ethene has a double bond, ethane has only single bonds	1
iii)	A saturated hydrocarbon has no double bonds An unsaturated hydrocarbon has some double bonds	1 1
b) i)	C_6H_{14}	1
ii)	A curve As the points get progressively closer to each other as the number of carbon atoms increases	1 1
iii)	Propane A value between -20 and -40°C	1 1
Total		10

Longer-answer questions

Question	Answers and guidance	Marks
1 a)	React ethene with steam at 300 °C and a pressure of 60–70 atm Use a phosphoric acid catalyst	1 1 1 1
b)	Any four points, but the answer must include a disadvantage and advantage to gain 4 marks <i>Advantages</i> for ethene: <ul style="list-style-type: none"> • readily available from crude oil • not dependent on harvests/possible droughts • will not use possible food sources/affect price of foods • it is quicker than fermentation for plant sugars: <ul style="list-style-type: none"> • carbon neutral • will not run out <i>Disadvantages</i> for ethene: <ul style="list-style-type: none"> • will run out • not carbon neutral for plant sugars: <ul style="list-style-type: none"> • dependent on harvests/possible droughts • will use possible food sources/affect price of foods • fermentation is a slow process 	4
Total		8

Question	Answers and guidance	Marks
2 a)	Add yeast to a glucose solution	1
	Description/diagram showing that oxygen/air is excluded	1
	Keep at temperature of about 30 °C	1
	Leave for several days/until yeast settles on bottom/no more carbon dioxide is produced	1
	Separate ethanol by (fractional) distillation	1
	$\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$	1
Total		6

Question	Answers and guidance	Marks
3	<p>Any five for 1 mark each from:</p> <p><i>Advantages of ethene as raw material</i></p> <ul style="list-style-type: none"> • quick reaction/growing crops takes a long time • easy to obtain • will not affect food prices/cause food shortages <p><i>Advantages of food crops</i></p> <ul style="list-style-type: none"> • renewable resource/will not run out • does not contribute to global warming • provides more employment <p>(disadvantages should be treated as advantages for the other process, e.g. raise food prices is an advantage for the use of ethene)</p> <p>Additional mark for concluding statement linking relevant advantages/disadvantages to either method of production</p>	<p>5</p> <p>1</p>
Total		6

Question	Answers and guidance	Marks
4 a)	Heat the ethanol	1
	pass over hot aluminium oxide	1
	$\text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$	1
b)	Takes a long time to produce ethanol from plants	1
	Will use land that could be used for food production	1
	Dependent on weather to grow crops/drought problems	1
c)	A substance that speeds up a reaction without being used up	1
Total		7

Question	Answers and guidance	Marks
5	<p>Any five for 1 mark each from:</p> <p><i>Points for plant materials</i></p> <ul style="list-style-type: none"> • renewable source of fuel • as oil gets more scarce supplies will be maintained. • will allow crude oil to be used for other more important uses. • carbon neutral source of fuel <p><i>Points for crude oil</i></p> <ul style="list-style-type: none"> • quicker to produce ethene • easy to obtain • using land for fuels will reduce capacity to feed world's population/poor will not be able to afford food <p>Additional mark for concluding statement linking relevant advantages/disadvantages to either method of production chosen</p>	5
Total		6